U.S. Department of Energy's

Office of Science

# Fusion Energy Sciences Program

## Budget Planning Meeting


www.ofes.fusion.doe.gov

**Dr. N. Anne Davies**
Associate Director
for Fusion Energy Sciences

*March 15, 2005*

# US Competitiveness

**“Given the rising bar for competitiveness, the United States needs to be in the lead or among the leaders in every major field of research to sustain its innovation capabilities.”**

***U.S. Competitiveness 2001: Strengths, Vulnerabilities and Long Term Priorities,*** **Council on Competitiveness**

# Office of Science

- **The Office of Science is the primary source of support for the Physical Sciences.**
  - Provides 42% of federal support to the physical sciences
  - Provides primary support to select sub-fields (e.g. high energy physics, nuclear physics, nuclear medicine, heavy element chemistry, plasma physics and magnetic fusion, and catalysis.)
  - Manages long-term, high-risk, high-payoff multidisciplinary science programs to support DOE missions
  - Directly supports (FY '05) the research of around 23,500 Ph.D.s, Post Docs and Graduate Students

- **Constructs and operates large scientific facilities for the future of science.**
  - Accelerators, light and neutron sources, nanotechnology research centers
    - Used by more than 19,000 researchers every year
    - Number of users expected to increase dramatically with Spallation Neutron Source (SNS) and nanocenter user facilities commencing operations
  - Linac Coherent Light Source begins construction
    - Ten billion times brighter, in the hard x-ray range, than any other light source in the world
    - new field of ultra-fast science

# Office of Science Missions

**Secure Energy Future**

- ITER: Abundant and clean energy for the future.
- Materials: Fabrication and performance for efficient energy production, storage and use: Spallation Neutron Source commences operations
- Nanoscience: Four Nanoscale Science Research Centers (NSRCs) will begin operations: Center for Nanophase Materials Sciences (Oak Ridge National Lab); Molecular Foundry (Lawrence Berkeley National Lab); Center for Integration Nanotechnologies (Sandia National Lab and Los Alamos National Lab); and Center for Nanoscale Materials (Argonne National Lab).
- Climate Change: Understanding the effects of energy production and use. Environmental measurements to test, and improve climate change prediction models. Determine the global carbon cycle. Perform basic research for biological sequestration of carbon in the biosphere.
- Research: Nanostructured materials; catalysis, membranes and gas separation; photovoltaic electrolysis and artificial photosynthesis; Genomics: GTL microbial production of hydrogen; funding the first round hydrogen research solicitation; solar energy—chromophors for increased solar cell efficiency; fusion energy and plasma science.

**Environment**

- Genomics: GTL -- Harnessing biotechnology to protect the environment; ecology baselines.
- Natural and accelerated bioremediation research
- Basic research for environmental management
- Carbon sequestration

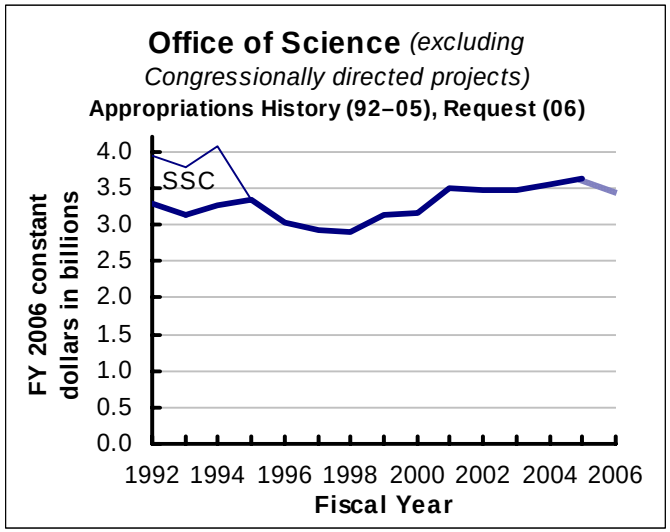
**Future of Science**

- Key Questions: Understanding the beginning of time, exploring the nature of energy and matter from quarks to the cosmos.
- Scientific Computation:
    - Next Generation Computing Architecture to improve performance for science and industry
    - Leadership Class Computing for science and economic competitiveness
- Scientific Workforce Development: Using the unique capabilities of the DOE laboratories for teacher professional development; enhancing the diversity of the scientific workforce
- Physical science enhancement of biomedical applications

# FY 2006 Funding 1.6% Below FY 2005 Appropriations (excluding Congressionally Directed Projects), 0.9% Above the FY 2005 Request

- A difficult budget year – however, the Office of Science continues to provide world leadership in science, and for energy security.

- The budget forces us to make tough choices. SC's prioritization provides for a strong and healthy future for U.S. science consistent with the 20-year facilities outlook.



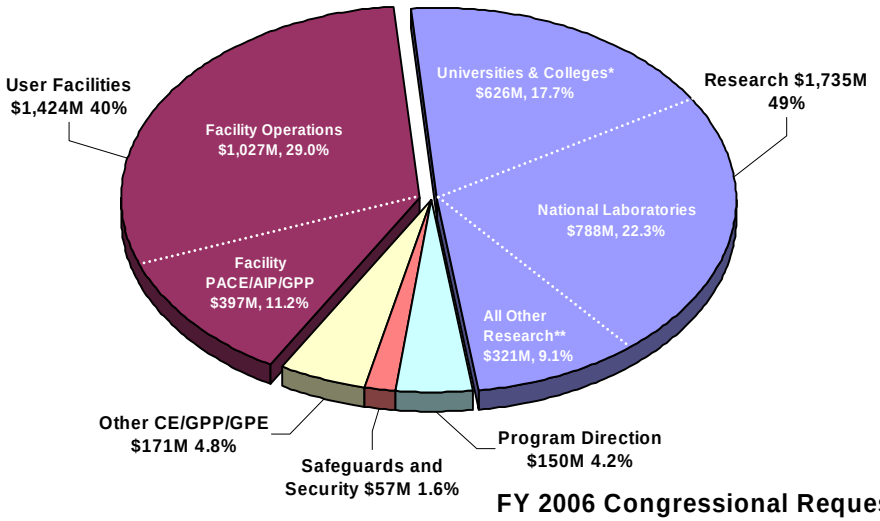
# Office of Science
# FY 2006 Congressional Budget Request

(dollars in thousands)

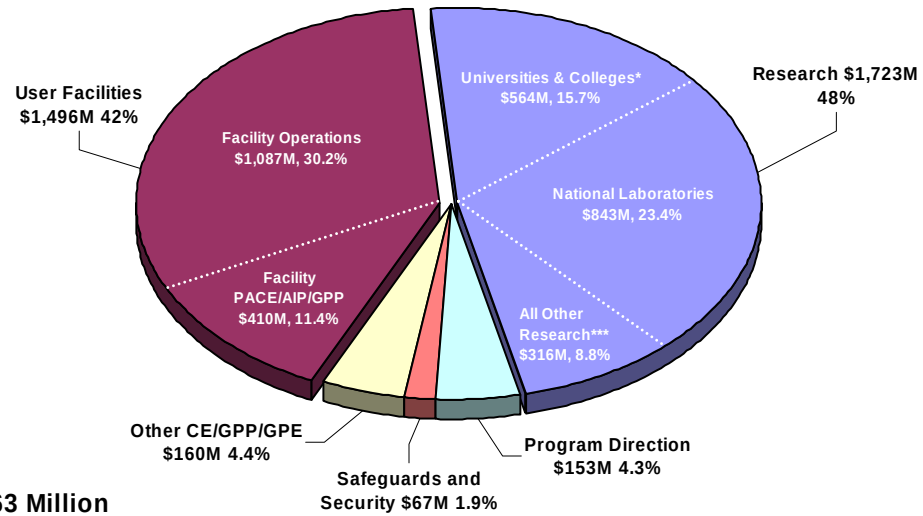
| | FY 2004 Comparable Approp. | FY 2005 President's Request | FY 2005 Comparable Approp. | FY 2006 President's Request | FY 2006 Request vs. FY 2005 Request | | FY 2006 Request vs. FY 2005 Appropriation | |
|---|---|---|---|---|---|---|---|---|
| **Science** | | | | | | | | |
| Basic Energy Sciences | 991,262 | 1,063,530 | 1,104,632 | 1,146,017 | +82,487 | +7.8% | +41,385 | +3.7% |
| Advanced Scientific Computing Research | 196,795 | 204,340 | 232,468 | 207,055 | +2,715 | +1.3% | -25,413 | -10.9% |
| Biological & Environmental Research | 624,048 | 501,590 | 581,912 | 455,688 | -45,902 | -9.2% | -126,224 | -21.7% |
| *(Congressionally-directed projects)* | *(136,798)* | *(——)* | *(79,608)* | *(——)* | *(——)* | *(——)* | *(-79,608)* | *(-100.0%)* |
| *(Core Biological and Environmental Research)* | *(487,250)* | *(501,590)* | *(502,304)* | *(455,688)* | *(-45,902)* | *(-9.2%)* | *(-46,616)* | *(-9.3%)* |
| High Energy Physics | 716,170 | 737,380 | 736,444 | 713,933 | -23,447 | -3.2% | -22,511 | -3.1% |
| Nuclear Physics | 379,792 | 401,040 | 404,778 | 370,741 | -30,299 | -7.6% | -34,037 | -8.4% |
| Fusion Energy Sciences | 255,859 | 264,110 | 273,903 | 290,550 | +26,440 | +10.0% | +16,647 | +6.1% |
| Science Laboratories Infrastructure | 55,266 | 29,090 | 41,998 | 40,105 | +11,015 | +37.9% | -1,893 | -4.5% |
| Science Program Direction | 150,277 | 154,943 | 153,706 | 162,725 | +7,782 | +5.0% | +9,019 | +5.9% |
| Workforce Development for Teachers and Scientists | 6,432 | 7,660 | 7,599 | 7,192 | -468 | -6.1% | -407 | -5.4% |
| Small Business Innovation Research/Technology Transfer | 114,915 | —— | —— | —— | —— | —— | —— | —— |
| Safeguards and Security | 56,730 | 67,710 | 67,168 | 68,712 | +1,002 | +1.5% | +1,544 | +2.3% |
| Subtotal, Science | 3,547,546 | 3,431,393 | 3,604,608 | 3,462,718 | +31,325 | +0.9% | -141,890 | -3.9% |
| Use of prior year balances | -11,173 | —— | -5,062 | —— | —— | —— | +5,062 | +100.0% |
| **Total, Science** | **3,536,373** | **3,431,393** | **3,599,546** | **3,462,718** | **+31,325** | **+0.9%** | **-136,828** | **-3.8%** |
| *(Total, excluding Congressionally-directed projects)* | *(3,399,575)* | *(3,431,393)* | *(3,519,938)* | *(3,462,718)* | *(+31,325)* | *(+0.9%)* | *(-57,220)* | *(-1.6%)* |

# Investments to Maintain U.S. Scientific Leadership and Ensure that Leading-edge Research Facilities will be Available for the Future

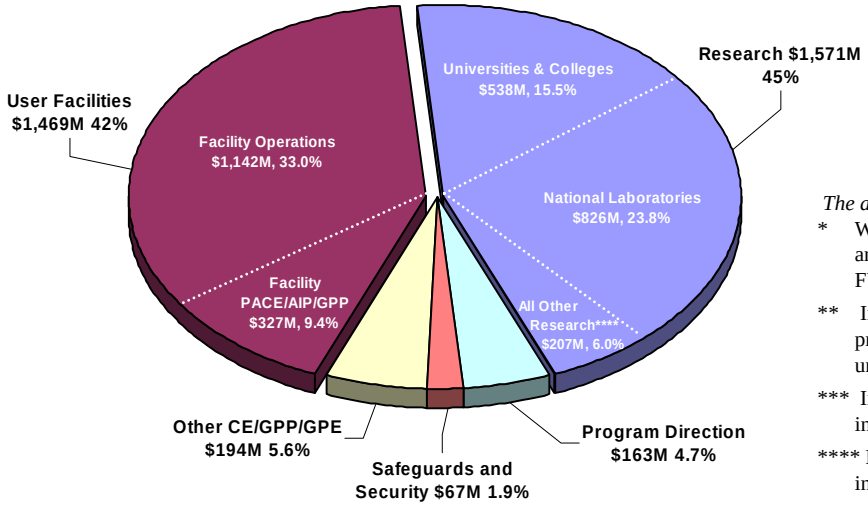
**FY 2004 Appropriation, $3,536 Million**




**FY 2005 Appropriation, $3,600 Million**




**FY 2006 Congressional Request, $3,463 Million**




*The area of each pie chart is proportional to the funding total for the year.*

* When pending FY 2005 Congressionally-directed university grants are awarded (currently in "all other" in FY 2005), FY 2004 and FY 2005 university funding will be approximately equal.

** Includes funding for SBIR/STTR, non-profits, other federal agencies, private institutions, and Congressionally-directed projects other than university grants.

*** Includes funding for, non-profits, other federal agencies, private institutions, and all Congressionally-directed projects.

**** Includes funding for non-profits, other federal agencies, and private institutions.

RLO 3/05

# The President's FY 2006 Budget Propels the United States into Leadership in the Following Areas:

- **Fusion --** ITER (fabrication begins) – will demonstrate the scientific and technological feasibility of creating and controlling a sustained burning plasma to generate energy**.**
- **Leadership Class Computing –** 40 combined TeraFlops (TF) system performance at the end of CY 2005 (20 TF "Red Storm" and 20 TF X1-E) – the most powerful computer for open science in the world.
- **Spallation Neutron Source –** SNS — world leading neutron source (by an order of magnitude) begins operation at ORNL
- **Nanotechnology –** four of five Nanoscale Science Research Centers begin operations in FY 06.
- **X-Ray Free Electron Laser --** start construction of Linac Coherent Light Source at SLAC – ushers in the field of ultra-fast science
- **High Energy Physics –** initial operations of the Neutrinos at the Main Injector (NuMI) project at Fermilab -- fundamental physics of neutrino masses and mixings. Large Hadron Collider at CERN (pre-operations, operation and maintenance of detectors, and computing and software infrastructure)
- **Nuclear Physics –** continue to use the unique capabilities of the Continuous Electron Beam Accelerator Facility (CEBAF) at Jefferson Laboratory and the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory for studies of the internal quark-gluon structure of nucleons and the properties of hot, dense nuclear matter.
- **Climate Change –** research to address the role of clouds. Invest in scientific infrastructure to develop, test, and run the climate change prediction models used in the international assessments of climate change. Continue study of the global carbon cycle and basic research for biological sequestration of carbon in the biosphere.
- **Genomics --** GTL will accelerate research underpinning the Department's ability to develop microbe-based biotechnology solutions for clean energy, carbon sequestration, and environmental remediation.

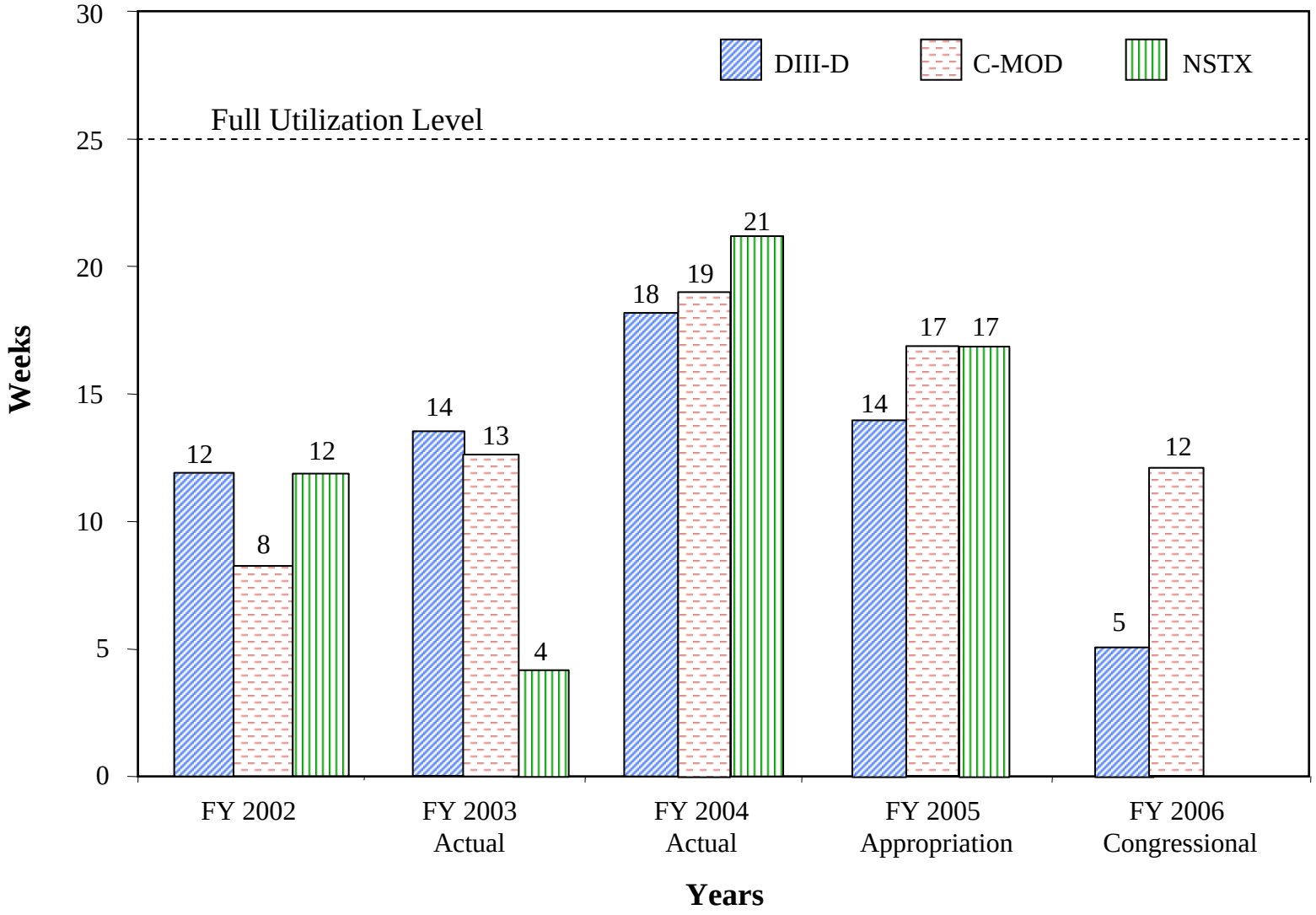
# FY 2006 Fusion Energy Sciences Congressional Budget Request

| | FY 2004 Actual | FY 2005 Appropriation | FY 2006 Congressional |
|---|---|---|---|
| Science | 142.7 | 155.1 | 142.8 |
| Facility Operations | 85.7 | 89.9 | 127.5 |
| Enabling R&D | 27.5 | 28.9 | 20.3 |
| *OFES Total* | *255.9* | *273.9* | *290.6* |
| | | | |
| DIII-D | 54.4 | 55.7 | 51.4 |
| C-Mod | 22.3 | 22.0 | 21.5 |
| NSTX | 35.6 | 34.5 | 30.7 |
| NCSX | 16.7 | 18.3 | 16.6 |
| ITER | 3.2 | 4.9 | 55.5 |
| Non-ITER | 252.7 | 269.0 | 234.9 |

# FY 2006 Fusion Program Highlights

- **Begin U.S. ITER Fabrication Effort ($55.5M, +$50.6M)**
  - $46M for MIE Project
  - $3.5M for Enabling R&D support
  - $6.0M for transitional activities that need to be completed before starting MIE
- **Close out fusion materials science research (-$7.3M)**
  - Shift materials research to BES
  - ITER will have to address materials needs as part of program
- **Cut back HEDP Research (-$7.2M)**
- **Reduce Major Facility operations and research (-$8.7M)**
  - No operation on NSTX, 5 weeks on DIII, 12 weeks on C-Mod
- **Eliminate one major concept in ICC program (-$3.4M)**
- **Reduce NCSX to FY 04 level (-$1.6M)**
  - Estimated 1 year delay and $4.5M increase in cost
- **Reduce Plasma Technologies to focus on ITER specifics (-$4.2M)**
- **Other reductions in Theory, Advanced Design and SBIR (-$2.1M)**

# Major Fusion Facilities Operating Times



# FY2006 Final ITER Preparations and Start of the U.S. Contributions to ITER MIE Project – Total of $55.5M

| | FY 2004 | FY 2005 | FY 2006 |
|---|---|---|---|
| ITER Preparations | $3.0M | $5.0M | $6.0M * |
| ITER Major Item of Equipment Project Annual Total Estimated Cost (TEC) Funding | 0 | 0 | $46.0M |
| ITER Major Item of Equipment Project Annual Other Project Cost (OPC) Funding | 0 | 0 | $3.5M |

- Preparations funding - completion of the ITER Transitional Arrangements, a framework used in anticipation of an International ITER Agreement. These ITA activities involve all six ITER Parties and provide analyses of various transitional issues including safety, licensing, project management, preparation of specifications and system integration and for the continuation of various technical activities of the U.S. scientists and engineers in laboratories, universities, and industry.

MIE Start

- TEC funding - procurement, fabrication and delivery of medium- and high- technology components, assignment of U.S. personnel to the ITER Organization abroad, and a provision of cash for the U.S. share of common costs at the ITER site for installation and testing.
- OPC funding - R&D and design in support of magnets, plasma facing components, tritium processing, fueling and pumping, heating and current drive, materials, and diagnostics.

* Discussions are under way about whether ITER Preparations funding in FY06 should be accounted for within the ITER Other Project Costs (OPC) and therefore the ITER Total Project Cost (TPC).

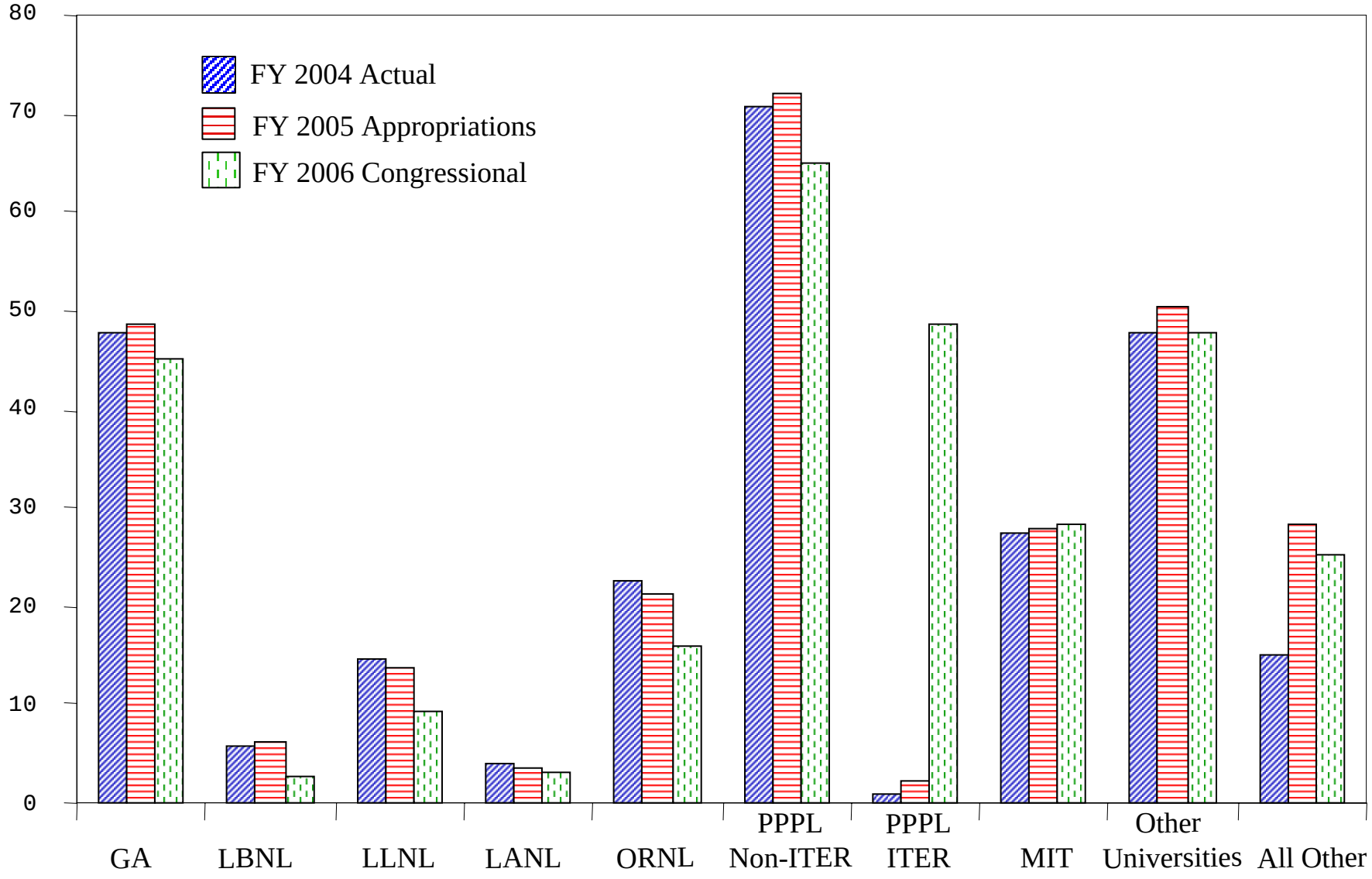
# Fusion Energy Sciences Budget by Institution

($ in Millions)

| Institution | FY 2004 Actual | FY 2005 Appropriation | FY 2006 Congressional |
|---|---|---|---|
| General Atomics | 47.6 | 48.3 | 45.2 |
| Lawrence Berkeley National Lab | 5.8 | 6.1 | 2.6 |
| Lawrence Livermore National Lab | 14.4 | 13.5 | 9.2 |
| Los Alamos National Lab | 3.9 | 3.5 | 3.2 |
| Oak Ridge National Laboratory | 22.5 | 20.7 | 15.8 |
| Princeton Plasma Physics Lab—Non ITER | 70.5 | 71.8 | 64.8 |
| Princeton Plasma Physics Lab--ITER | 1.0 | 2.4 | 48.5 |
| Massachusetts Institute of Technology | 27.3 | 27.8 | 28.2 |
| Other Universities | 47.7 | 50.6 | 47.8 |
| All Other | 15.2 | 29.2 | 25.3 |
| ***Total*** | ***255.9*** | ***273.9*** | ***290.6*** |

# Fusion Energy Sciences Funding by Institution

($ in Millions)



# Summary of Fusion Energy Sciences FY 2006 Program

**ITER** ($55.5M, +$50.6M)

- $46M for MIE Project
- $3.5M for Enabling R&D Support
- $6.0M for transitional activities that need to be completed before starting MIE

**Science** ($142.8M, -$12,3M)

- Cutback Heavy Ion Beam research (-$7.2M)
- Eliminate one major concept in ICC program (-$3M)
- Increase DOE/NSF Partnership in Basic Plasma Science and engineering (+$1.6M)
- Reduce research at major facilities (-$0.7M)
- Reduce funding at MST (-$0.4)
- Reduce funding for Theory (-$0.8)
- Reduce funding for NCSX (-$0.1)
- SBIR/STTR at mandated level (-$0.7M)
- Fund remaining elements at the FY 2005 level

**Facilities Operations** ($127.5M, +$37.6M)

- Curtail operations at DIII-D, C-Mod, and NSTX from 14/17/17 weeks in FY 2005 to 5/12/0 weeks in FY 2006 (-$8.0M)
- Reduce funding for NCSX to $1.6M below the FY05 level causing additional schedule delay and cost increase
- GPE/GPP/Other increases ($0.1M)

**Enabling R&D** ($16.8M, $-12.1M)

- Terminate Materials Science Research (-$7.3M)
- Reduce Plasma Technologies program by $4.2M
- Terminate Next Step Design activity (-$0.6M)